TABLE 1.—*Solar radiation intensities during October, 1917*—Continued

Santa Fe, N. Mex.

Date.	Sun's zenith distance.									
	0.0°	48.3°	60.0°	66.5°	70.7°	73.6°	75.7°	77.4°	78.7°	79.8°
	Air mass.									
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
A. M.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Oct. 5	....	....	....	....	1.24	1.19	1.13	1.08	1.06	......
9	....	1.57	....	1.37	1.29	1.27	1.21	1.15	1.07	......
15	....	1.50	....	....	....	1.21	1.15	1.09	1.04	......
16	....	1.49	....	....	1.21	1.15	1.11	1.08	....	......
18	....	1.50	1.40	....	....	1.17	1.10	1.03	0.97	0.91
19	....	1.52	1.45	1.40	1.34	1.30	1.25	1.21	1.17	1.14
20	....	1.53	1.45	1.39	1.33	1.27	1.27	1.22	1.18	1.13
22	....	1.48	1.44	1.40	....	1.34	1.29	1.22	1.15	......
27	....	1.51	1.38	1.31	1.25	1.20	....	....	1.09	......
30	....	1.53	1.44	....	....	1.31	....	....	1.24	......
Means	....	1.51	1.43	1.37	1.28	1.24	1.19	1.13	1.11	1.06
Departure from 5-year normal	....	+0.03	+0.06	+0.05	+0.05	+0.06	+0.04	−0.01	+0.01	−0.02
P. M.										
Oct. 8	....	....	1.39	1.27	1.26	1.17	....	....	....	......
9	....	1.52	1.46	1.39	1.32	1.25	1.18	1.13	....	......
11	....	1.52	1.41	1.31	1.24	1.18	1.13	....	....	......
16	....	....	1.42	1.34	1.27	1.21	....	....	....	......
18	....	1.47	1.34	....	....	....	....	....	....	......
19	....	1.49	....	1.32	1.23	....	1.13	....	....	......
20	....	....	1.42	....	....	....	....	....	....	......
22	....	....	1.39	....	....	....	....	....	....	......
27	....	....	1.34	....	....	....	....	....	....	......
30	....	....	1.45	1.38	1.32	1.25	1.20	1.15	1.11	......
Means	....	1.50	1.40	1.34	1.27	1.21	1.16	(1.14)	(1.11)	......
Departure from 2-year normal	....	+0.03	+0.02	+0.04	+0.04	+0.06	+0.07	+0.13	+0.26	......

TABLE 2.—*Vapor pressures at pyrheliometric stations on days when solar radiation intensities were measured.*

Washington, D. C.			Madison, Wis.			Lincoln, Nebr.			Santa Fe, N. Mex.		
Dates.	8 a.m.	8 p.m.	Dates.	8 a.m.	8 p.m.	Dates.	8 a.m.	8 p.m.	Dates.	8 a.m.	8 p.m.
1917.	*mm.*	*mm.*	1917.	*mm.*	*mm.*	1917.	*mm.*	*mm.*	1917.	*mm.*	*mm.*
Oct. 1	6.76	6.02	Oct. 1	6.02	6.50	Oct. 2	7.87	8.18	Oct. 5	5.79	4.95
2	6.76	7.29	6	4.95	4.95	3	7.04	8.48	8	5.16	5.56
3	7.57	9.14	8	3.63	3.30	4	7.87	7.29	9	4.95	3.63
5	10.59	10.97	13	2.62	3.63	9	6.76	4.37	11	3.00	4.17
6	6.50	4.75	15	4.37	4.57	10	4.57	4.95	15	3.63	4.95
13	3.81	5.56	16	3.99	3.99	11	5.16	2.36	16	4.17	4.17
22	4.95	5.36	27	3.81	3.45	12	2.26	1.52	18	2.36	1.60
25	5.16	5.36	....	......	......	13	3.15	4.57	19	2.16	2.74
26	5.36	7.57	....	......	......	14	3.81	5.16	20	2.74	3.15
27	7.57	12.24	....	......	......	15	5.16	5.16	22	2.36	3.63
31	2.62	3.30	....	......	......	22	3.81	3.45	27	2.36	2.87
						23	2.87	2.74	30	1.78	2.36
						26	3.63	6.02	....	......	......
						27	3.15	3.99	....	......	......
						31	2.49	2.74	....	......	......

TABLE 3.—*Daily totals and departures of solar and sky radiation during October, 1917.*

[Gram-calories per square centimeter of horizontal surface.]

Day of month.	Daily totals.		Departures from normal.		Excess or deficiency since first of month.	
	Washington.	Madison.	Washington.	Madison.	Washington.	Madison.
1917.	*calories.*	*calories.*	*calories.*	*calories.*	*calories.*	*calories.*
Oct. 1	307	422	−33	137	−33	137
2	442	292	106	11	73	148
3	424	146	92	−132	165	16
4	356	290	28	16	193	32
5	292	203	−32	−68	161	−36
6	344	376	23	108	184	72
7	414	339	95	74	279	146
8	231	345	−85	84	194	230
9	58	61	−255	−197	−61	33
10	242	142	−69	−113	−130	−80
11	278	27	−30	−225	−160	−305
12	104	90	−202	−159	−362	−464
13	414	310	111	64	−251	−400
14	401	286	100	43	−151	−357
15	363	361	65	121	−86	−236
16	297	344	1	107	−85	−129
17	349	48	55	−186	−30	−315
18	71	46	−220	−186	−250	−501
19	144	117	−145	−112	−395	−613
20	379	91	92	−135	−303	−748
Decade departure			....	....	−173	−668
21	384	270	99	47	−204	−701
22	336	167	48	−53	−156	−754
23	215	231	−65	13	−221	−741
24	48	281	−230	66	−451	−675
25	291	268	15	56	−436	−619
26	336	38	62	−172	−374	−791
27	294	239	22	31	−352	−760
28	333	60	63	−146	−289	−906
29	88	94	−180	−110	−469	−1,016
30	81	192	−185	−10	−654	−1,026
31	292	224	27	23	−627	−1,003
Decade departure			....	....	−324	−255
Excess or deficiency since first of year — calories			....	....	−6,608	+677
Excess or deficiency since first of year — per cent			....	....	−5.6	+0.6

ATMOSPHERIC OPTICAL DISTURBANCES, FALL OF 1911 TO FEBRUARY, 1917.[1]

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By C. DORNO.

[Davos Observatory, Davos, Switzerland, July, 1917.]

Systematic observations on the polarization of skylight, twilight phenomena, and on Bishop's Ring have been carried on at the Davos Observatory from the Fall of 1911 to February, 1917, in addition to continued pyrheliometric measurements and determinations of solar and sky radiation in many portions of the spectrum.[2] These all agree in showing: The great Katmai disturbance which, in June, 1912, brought to a close a period of exceptionally great purity of our atmosphere, very gradually came to an end toward the close of the year 1914. Even at the beginning of 1915 the atmosphere had not wholly recovered the degree of purity which characterized 1911. In the course of 1915 rapidly disappearing individual disturbances could be recognized; they rapidly increased during the first half of 1916, and in the second half of 1916 led to a new, uninterrupted period of disturbance having a milder character than that of 1912.

In the years 1915 and 1916 Bishop's Ring did not always present the appearance of a silvery white "inner disk" surrounded by a less brilliant bluish-white "outer

[1] Translated for the MONTHLY WEATHER REVIEW from the separate: Atmosphärisch-optische Störungen (Herbst 1911 bis Februar 1917), von *C. Dorno.* Astronom. Nachr., Nr. 4899, August, 1917, Band 205.—C. A., jr.

[2] There are in course of publication in the Abhandlungen d. Kgl. preuss. Meteorol. Instituts, detailed studies of twilight observations and ring phenomena, accompanied by a large amount of tabulated material. More complete extracts from these studies appeared in the April-Mai and the Juni-Juli issues of the Meteorologische Zeitschrift for 1917. There are still in preparation the chapters on "Himmelshelligkeit und Himmelspolarisation" and "Sonnenstrahlung."

disk" whose periphery was reddish white. On the contrary, the phenomenon consisted of a system of rings of manifold colors and brilliancies, its maximum radii corresponding to those of the Bishop's Rings of 1912–1914 and 1885–1887, while nearer the sun there reappeared a brighter blue "intermediate disk," a blue-white [wreath] ("Kranz") and a yellow to whitish "corona." The variations in the visibility of these divisions, of their intensities as to definition and brightness, of the radial magnitudes of the different rings as depending on the one hand upon the sun's altitude and on the other upon atmospheric conditions—the systematic observations of which at Davos was stimulated by J. Maurer's publications[3]—when all taken in connection with the march of the relative sun-spot numbers and of the intensity of solar radiation and in the light of the evidence and theoretical considerations detailed elsewhere, lead to the following briefly stated conclusions:

The plain Bishop's Ring consisting of simply an inner and an outer disk, as seen in 1885–1887 and 1912–1914, arises through the diffraction due to the presence of a very large number of particles of very different sizes, some of which float at greater altitudes but chiefly are found filling all the intermediate and lower levels of the troposphere. The light-scattering effect of these numerous and multi-form particles increases the brilliance of the inner disk and interferes with the perception of the more delicate differences in brightness close to the sun, in so far as such differences exist at all. If such a ring endures without interruption for a long time and with scarcely varying intensity, then its terrestrial origin is very probable. The magnitude of the smallest diffracting particle may be computed by Pernter's theory; the average for those accompanying the Katmai disturbance, which began in 1912 and gradually died out toward the end of 1914, was found to be a diameter of 0.00089 mm. as against one of 0.00152 mm. for those of the Krakatao disturbance of 1885–1887.

Diffusion plays scarcely any rôle in the differentiated optical phenomena of the year 1915–16. These were due to diffraction phenomena caused by quite exceptionally small particles of very slightly varying size and—as the limits of the different brilliancies indicate—restricted kinds or forms, which probably without exception floated at greater altitudes (15 to 20 km.) and consisted chiefly if not altogether of ice crystals. Essentially, therefore, they are probably identical with the frequently observed super-cirri (Übercirren). The size of the smallest particles is computed to be 0.00075 mm, while preliminary computations indicate that the size of the largest may be estimated as 10 to 40 times as great—i. e., they are of the size of the cloud-forming elements. The regularity of the ratios obtaining between the radii of the different rings invites speculation concerning the number, forms, and relative sizes of the particles. There appear to be no grounds for the assumption that the small rings arise in lower atmospheric strata than do the large ones. The increase of the radii with decreasing solar altitudes takes place more rapidly for the small radii than for the larger ones, and is due to the increasing intensity of the diffracted rays with simultaneous decrease in the intensity of the direct rays, to the increasing percentage of long waves in the rays and the stronger diffusion by the portion of the atmosphere nearer the horizon.

The diffracting ice crystals are regarded as being formed through the agency of condensation-nuclei thrown out by the sun; terrestrial volcanic activity probably had but a subordinate part in the disturbances of the years 1915 and 1916. In support of this view are pointed out—

(1) The frequency and spasmodic character of the appearance and disappearance of the phenomena;

(2) That during the time of the completely disconnected individual disturbances up to July, 1916, almost without exception there was a synchronism between the beginnings of more pronounced solar activity of the ring phenomena and of decrease in insolation (Strahlungsverlust); and that after the disturbance had assumed a continuous character in the second half of 1916, plainly recognizable intensifications were repeatedly found to synchronize with the beginning of a more pronounced solar activity.

(3) The persistently similar character of the decay of the individual disturbances, viz, first the disappearance of the great disk, the longer duration of the small ones, not rarely the sudden replacing of the great disk by a small one—i. e., the small nuclei of condensation evaporating sooner than the large ones.

Condensation-nuclei of solar origin are regarded as including all that may be regarded as exciting the auroræ. Comparisons of variations in intensity at numerous and quite widely distributed points on the earth's surface could give some idea of the path of the incident particles through the earth's atmosphere.

The connection between intensity of solar activity and the occurrence or strengthening of the "telluric solar corona"[4] was a regular and intimate one at Davos during the period of observation. Only a long period of observations conducted simultaneously at widely separated mountain observing stations can determine whether or no this connection always exists. The variation in the degree of purity of the atmosphere, caused by such a possible continual connection, would exert, on the incoming and outgoing radiation and the general circulation of the atmosphere, an influence not to be disregarded as a meteorological factor. At present one is not inclined to ascribe a high value to the magnitude of such an influence, for according to existing observations the incident radiation is weakened for but a short time just at the beginnings of the disturbances and of the stronger development of the outer and the inner disks, and it recovers rapidly as soon as the differentiated small rings becomes recognizable. It will, however, be necessary to devote all our attention to the further development of the phenomena under the influence of further increasing solar activity.

Variations in the solar constant can be determined with certainty only when one takes into account the apparently frequent local and temporal variations in terrestrial atmospheric transparency (purity) at a number of localities and if possible at the antipodes.

Meteorological influences introduce an annual period in the ring phenomena, in so far as such influences affect the visibility and definition. An annual period conditioned by the dust masses located in the ecliptic seems to be not wholly out of the question. In any case the heaping of disturbances in April, June, and August, as observed in the past, should be kept in mind in future work.

[3] Maurer, J. *in* Astronomische Nachrichten, Nos. 4813 (201:247), 4854 (203:99), and 4875 (204:45); also elsewhere.

[4] This term was proposed by J. Maurer to include all the ring phenomena, and the author here indorses the proposal.—*C. Dorno.*